Crossons-Longview Forest Restoration Project Environmental Assessment

Hydrology and Soils Specialist Report V3

South Platte Ranger District
Pike National Forest
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1. INTRODUCTION

The purpose of the Crossons-Longview Forest Restoration Project is to restore sustainable forest conditions that are resilient to fire, insects, and diseases, while providing for diverse wildlife habitats, recreational opportunities, and sustainable watershed conditions. The specific purposes of this project are:

- To reduce the potential of large-scale, high-intensity wildfire with uncontrollable fire behavior, such as active crown fire.
- To reduce the potential that a wildfire would negatively affect public water supplies from subsequent severe flooding and sedimentation.
- To improve forest health, vigor, and resilience to large-scale fire, insects and disease.
- To enhance wildlife habitat through the reduction of the potential for high-intensity wildfires, enhancement of shrublands and aspen habitat, and Pawnee montane skipper habitat.

2. PROJECT DESCRIPTION

The South Platte Ranger District of the Pike and San Isabel National Forest proposes to treat 9,574 acres within the 22,729 acre Crossons-Longview Project Area to move the montane forest ecosystem towards historic conditions. The proposed actions would alter forest stand and understory conditions and would be accomplished by a combination of mechanical harvesting and hand treatment. Specific actions would be dependent on site-specific conditions and the vegetation type; however, actions would include thinning, created openings, and prescribed burning. Professional judgment would be used, within guidelines identified in the Environmental Assessment and taking into consideration the terrain and vegetative type, to determine which one or combination of treatments are most appropriate for individual treatment sites. Approximately 55 percent of the treatment areas are located within 0.5 miles of existing roads, with 33 percent of those areas treated by hand due to slopes between 35-60 percent. Approximately 61 percent of the treatment areas lie on slopes of 0-35 percent and would be considered appropriate for treatment with traditional harvesting equipment and commercial product removal. The treatments on slopes between 35-60 percent would likely be hand treatments. Where possible, vegetation treatments would take into consideration previously treated areas and/or past burned areas in order to increase the overall landscape benefit.

The Proposed Action does not include the establishment of any new system roads, however, approximately 10 miles of temporary roads would be used to access the proposed action treatment areas. The target vegetation areas are identified on Table 1 and Figure 1. It is expected that project activities would take approximately 10 years to treat the proposed treatment area.

Table 1. Crossons-Longview Alternative B -Proposed Treatment Areas

Vegetation Type	Area (acres)	Percentage
Xeric Ponderosa pine	4,581	49%
Mesic Ponderosa pine	3,684	38%
Mixed Conifer	603	6%
Lodgepole pine	557	6%
Aspen	121	1%
Shrubs	28	<1%
Total	9,574	

Alternative C was developed in response to a concern that increasing access through the use of temporary roads would cause some negative effects. Alternative C proposes that minimal temporary roads will be built to accomplish the project's purpose and need. Temporary roads would be limited to short segments needed to accomplish the treatments, such as jump-up spurs. Relying solely on the existing road network will lessen the ability for product removal and will shift treatment methods toward more mastication and hand thinning. This alternative seeks to balance forest restoration with concerns about expanding the existing road network.

Because minimal temporary roads will be constructed, all treatment must occur off of existing roads, limiting the area that can be treated. It is assumed that all treatment will occur within 0.5 miles of existing roads, reducing the available treatment area to 6,325 acres. Table 2 presents the proposed treatment area by vegetation type for Alternative C.

Table 2. Crossons-Longview Alternative C - Proposed Treatment Areas

Vegetation Type	Area (acres)	Percentage
Xeric Ponderosa pine	2,919	46%
Mesic Ponderosa pine	2,500	40%
Mixed Conifer	422	7%
Lodgepole pine	354	6%
Aspen	115	1%
Shrubs	16	<1%
Total	6,325	

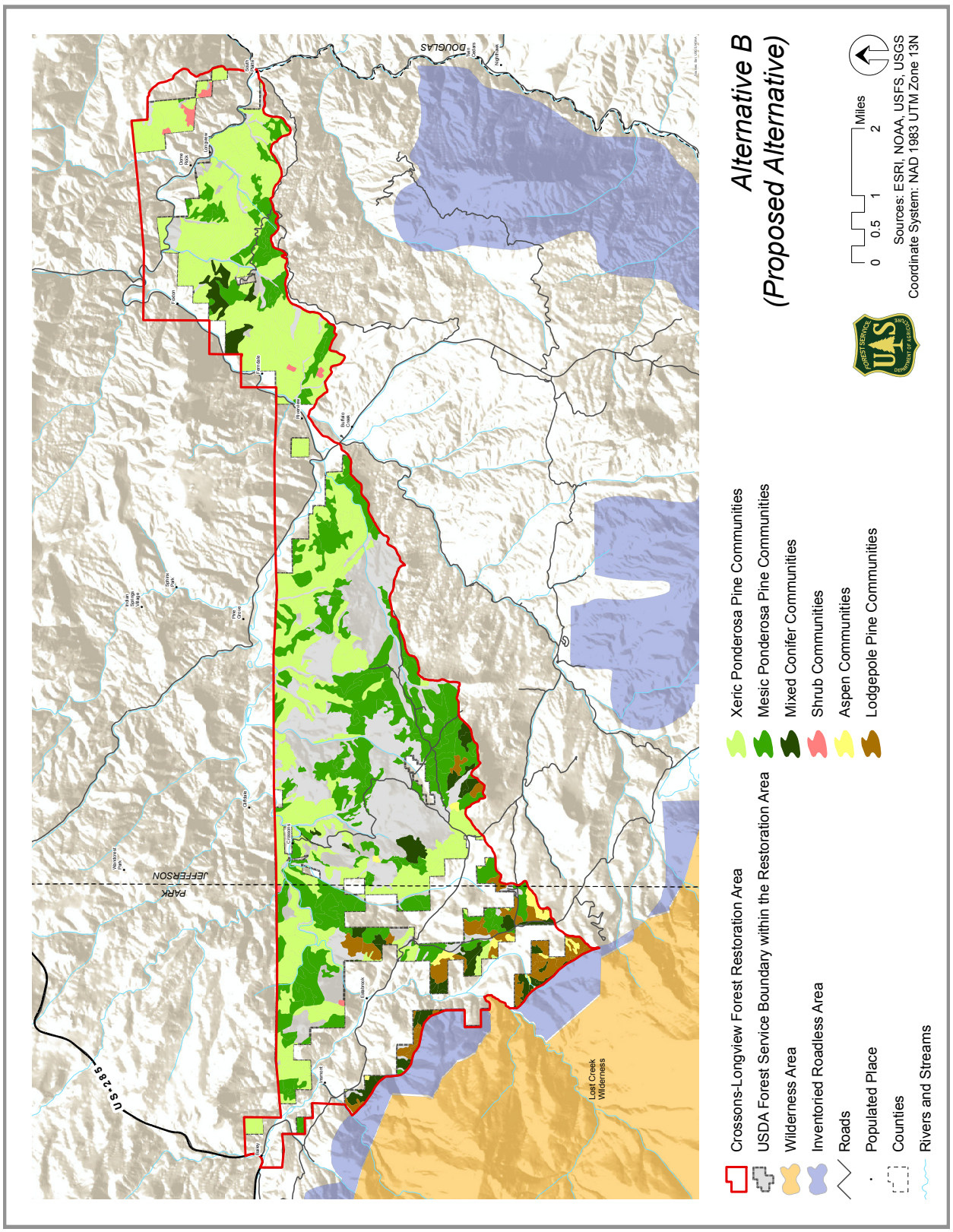

Figure 1. Crossons-Longview Treatment Area Map

Watershed boundaries were developed used the existing national network of delineated watersheds (Federal Geographic Data Committee 2004). Sixth-level (12-digit) watersheds, typically 16-63 square miles or 10,000-40,000 acres, were used to characterize and frame this analyses for the Crossons-Longview Project Area. There are 8 sixth-level watersheds in the Crossons-Longview Project Area (Table 3 and Figure 2). The total watershed area is greater than the Crossons-Longview Project Area because portions of the watersheds are located outside of the Crossons-Longview Project Area boundaries (Table 3 and Figure 2). The Crossons-Longview Project Area covers approximately 22,729 acres and the Vegetation Treatment Areas cover approximately 9,600 acres. The total watershed area for the 8 watersheds is 169,639 acres.

Table 3. Crossons-Longview Project Area Watersheds

Sixth-level Watershed	Hydrologic Unit Code (HUC)	Watershed Area (acres)	Watershed Area in Crossons-Longview Project Area (acres)	Watershed Area in Crossons-Longview Project Area (%)
Bailey	101900020204	15,563	1,985	12.8%
Buffalo Creek	101900020303	20,827	35	0.2%
Craig Creek	110200020203	35,538	1,909	5.4%
Deer Creek	110200020301	17,252	46	0.3%
Last Resort Creek-North Fork South Platte River	110200020305	30,895	6,066	19.6%
Pine Creek-South Platte River	110200020408	16,139	2	0.0%
Rowland Gulch-North Fork South Platte River	110200030304	18,323	12,684	69.2%
South Platte Canyon	110200030701	15,102	2	0.0%
	Totals	169,639	22,729	13.4%

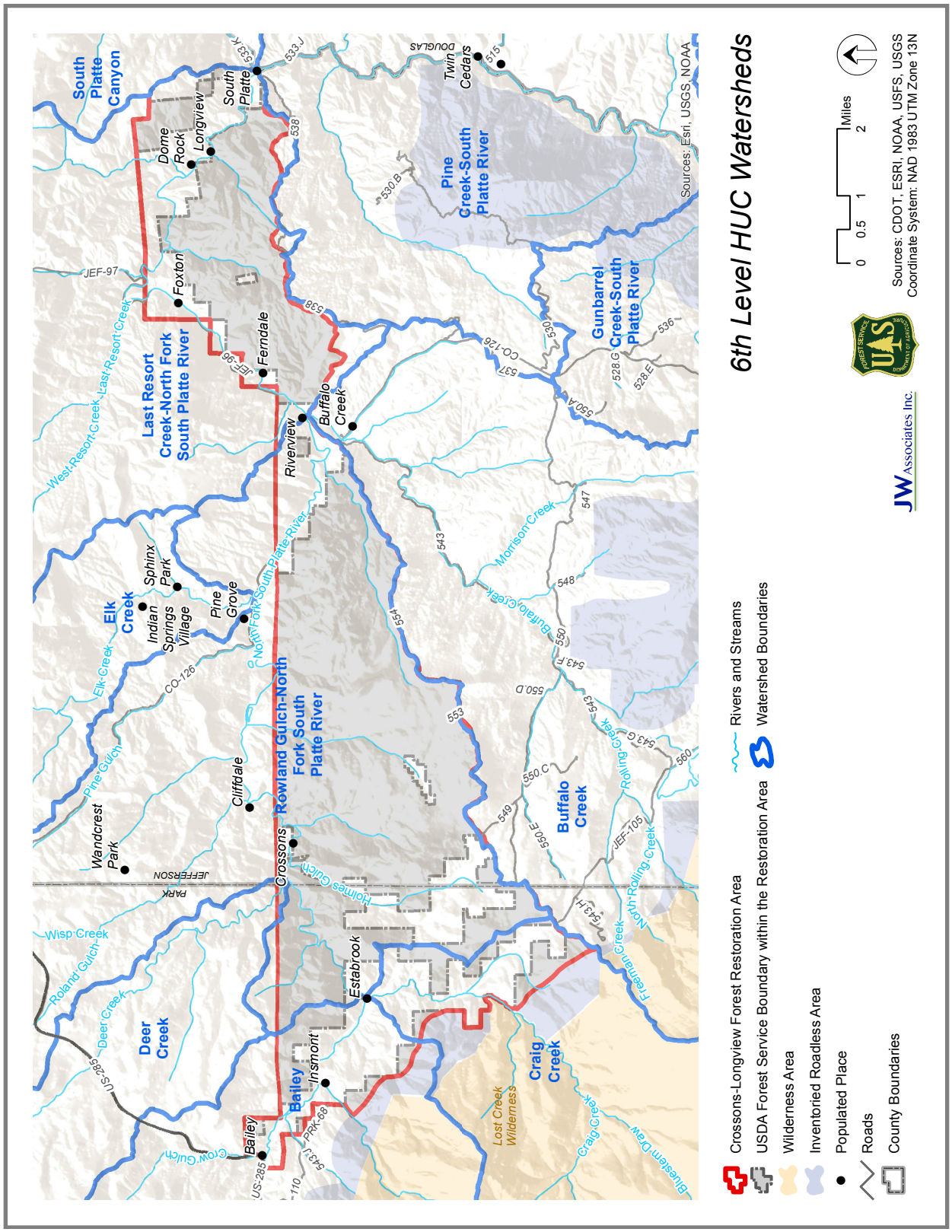

Figure 2. Crossons-Longview Project Area Watersheds

3. REGULATORY FRAMEWORK

3.1 NATIONAL FOREST MANAGEMENT ACT

The Land and Resource Management Plan for the Pike and San Isabel National Forests; Comanche and Cimarron National Grass Lands (USDA 1984), as amended, provides the framework to guide the day-to-day resource management operations of the Pike-San Isabel National Forests and subsequent land and resource management decisions made during project planning. The 1976 National Forest Management Act (NFMA) requires that site-specific project decisions must be consistent with the Forest Plan. Forest Plan goals and objectives guide the identification and selection of potential agency projects. The determination of whether or not an individual project is consistent with the Forest Plan is based on whether or not the project adheres to forest-wide and management area standards.

The Forest Plan includes specific management direction for different land areas. These land areas are called Management Areas. There are four different Management Areas within the Crossons-Longview Project Area these include:

- MA-2B: Rural and Roaded Natural Recreation Opportunities
- MA-5B: Big Game Winter Range
- MA-7A: Wood-Fiber Production and Utilization
- MA-9A: Riparian Area Management

The Forest Plan has some specific goals, and standards and guidelines that are directed at water resources.

3.1.1 Forest Plan Goals

- Maintain or improve water quality to meet Federal and State standards and increase the average annual water yield.
- Increase water yield through land treatment measures consistent with other resource and water quality standards.
- Protect riparian areas and wetlands from degradation.

3.1.2 Forest Plan General direction, standards and guidelines

Water Resource Improvement and Maintenance (F05, 06)

1. Maintain instream flows and protect public property and resources
2. Improve or maintain water quality to meet State and Federal water quality standards. However, where the natural background water pollutants cause degradation, it is not necessary to implement improvement actions. Short-term or temporary failure to meet some parameters of the State standard, such as increased

sediment from road crossing construction or water resource development may be permitted in special cases.

3. Develop a schedule of water yield treatments within fourth-order watersheds which attains desired water yield increases while maintaining stream channel stability.
    a. Provide mitigation measures necessary to prevent increased sediment yields from exceeding "threshold limits" (as determined by "State of the Art" modeling [HYSED] or actual measurements) identified for each (fourth-order) watershed.
4. Rehabilitate disturbed areas that are contributing sediment directly to perennial streams as a result of management activities to maintain water quality and re-establish vegetation cover.
    a. Reduce to natural rate any erosion due to management activity in the season of disturbance and sediment yields within one year of the activity through necessary mitigation measures such as water-barring and revegetation.

<u>Soil Resource Management (KA1)</u>

1. Maintain soil productivity, minimize man-caused soil erosion, and maintain the integrity of associated ecosystems.
    a. Use site preparation methods which are designed to keep fertile, friable topsoil essentially intact.
    b. Give roads and trails special design considerations to prevent resource damage on capability areas containing soils with high shrink-swell capacity.
    c. Provide adequate road and trail cross drainage to reduce sediment transport energy.
    d. Revegetate all areas capable of supporting vegetation, disturbed during road construction and/or reconstruction to stabilize the area and reduce soil erosion. Use less palatable plant species on cuts, fills, and other areas subject to trampling damage by domestic livestock and big game to discourage grazing by herbivores.
    e. Prevent livestock and wildlife grazing which reduces the percent of plant cover to less than the amount needed for watershed protection and plant health.
    f. Place tractor-built firelines on the contour, where possible, and avoid use of tractors on highly erodible sites.
    g. Remove bridges and culverts, eliminate ditches, outslope roadbed, remove ruts and berms, install permanent drainages and establish protective vegetative cover on all temporary roads after roads have served project purposes. Do the same for all roads removed from the transportation system.
    h. Minimize soil compaction by reducing vehicle passes, skidding on snow, frozen or dry soil conditions, or by off-ground logging systems.
    i. Restore soil disturbance caused by human use to soil loss tolerance levels commensurate with the natural ecological processes for the treatment areas.
2. Identify at the project level, upland areas that are immediately adjacent to Riparian (Prescription 9A) Management Areas. Adjacent upland areas are those portions of a management area which, when subjected to management activities, have a potential for directly affecting the condition of the adjacent Riparian Management Area. The magnitude of effects is dependent upon slope steepness, and the kind, amount, and location of surface and vegetation disturbance within the adjacent upland unit.

3.1.3 *Forest Service Manual*

The Forest Service Manual (FSM) 2500 series provides regulations and guidance for watershed management on National Forest lands.

3.2 CLEAN WATER ACT

The Clean Water Act's goal is to maintain the chemical, physical and biological integrity of the nation's waters. Compliance with state and federal pollution control measures is required. It contains an antidegradation clause, and control of nonpoint pollution through the use of best management practices.

3.2.1 *Beneficial Uses*

Under 09-MU-11020000-058 (6-30-09 extended to July 2015) it is agreed upon between United States Forest Service and Colorado Department of Natural Resources "The Forest Service and the DNR will seek to integrate federal and State responsibilities into respective and mutual decision making processes." The Colorado Department of Public Health and Environment Water Quality Control Commission has assigned beneficial or protected uses of the surface waters in the Crossons-Longview Project Area through Regulation No.31 - The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31). These uses are protected by water quality standards. Waters are classified by the uses for which they are presently suitable or intended to become suitable. Table 4 lists the beneficial use classifications for each watershed in the Crossons-Longview Project Area (Note: The definitions are provided in the footnotes).

Table 4. Crossons-Longview Beneficial Uses by Watershed[1]

Watershed	Stream Segment Designation	Classification
All Watersheds in Project Area	4. Mainstem of the North Fork of the South Platte River, including all tributaries and wetlands from the source to the confluence with the South Platte River, except for specific listings in Segments 1b, 5a, 5b, and 5c.	Aq Life Cold 1, Recreation E Water Supply, Agriculture
Uppers Portions of Bailey and Deer Creek Watersheds (upstream of Project Area)	1b. All tributaries to the South Platte River, including wetlands within the Lost Creek and Mt. Evans Wilderness Areas.	OW, Aq Life Cold 1, Recreation E Water Supply, Agriculture

[1] The following classification definitions apply:

Aq Life Cold 1 - These are waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species.

Recreation E - These surface waters are used for primary contact recreation or have been used for such activities since November 28, 1975.

Water Supply - These surface waters are suitable or intended to become suitable for potable water supplies. After receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration, and disinfection with chlorine or its equivalent) these waters will meet Colorado drinking water regulations and any revisions, amendments, or supplements thereto.

Agriculture - These surface waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.

OW - Outstanding Waters

3.3 Watershed Conservation Practices

FSH 2509.18 – Soil Management Handbook, FSH 2509.25 Watershed Conservations Handbook and National Best Management Practices (BMPs) for Water Quality Protection on National Forest System (NFS) Lands, (Forest Service 0596-AC71) Proposed Directives for National Best Management Practices (BMPs) for Water Quality Protection on National Forest System (NFS) Lands, and WCP Handbook – National Core BMPs Cross-reference Vol. 1 – National Core BMPs for WCP Design Criteria all provide direction and BMPs applicable to this project. The following WCPs are applicable to this project.

11.1 Management Measure (1) - Manage land treatments to conserve site moisture and to protect long-term stream health from damage by increased runoff.

11.2 Management Measure (2) - Manage land treatments to maintain enough organic ground cover in each land unit to prevent harmful increased runoff.

12.1 Management Measure (3) - In the water influence zone next to perennial and intermittent streams, lakes and wetlands, allow only those actions that maintain or improve long-term stream health and riparian ecosystem condition.

12.2 Management Measure (4) - Design and construct all stream crossings and other instream structures to provide for passage of flow and sediment, withstand expected flood flows, and allow free movement of resident aquatic life.

12.3 Management Measure (5) - Conduct actions so that stream pattern, geometry, and habitats are maintained or improved toward robust stream health.

12.4 Management Measure (6) - Maintain long-term ground cover, soil structure, water budgets, and flow patterns of wetlands to sustain their ecological function.

13.1 Management Measure (9) - Limit roads and other disturbed sites to the minimum feasible number, width, and total length consistent with the purpose of specific operations, local topography and climate.

13.4 Management Measure (12) – Reclaim roads and other disturbed sites when use ends, as needed, to prevent resource damage.

14.1 Management Measure (13) - Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area.

14.2 Management Measure (14) - Maintain or improve long-term levels of organic matter and nutrients on all lands.

The National Best Practices Management for Water Quality Crosswalk with Contractual Clauses and Provisions related to Mechanical Vegetation Management Activities also provide direction for BMPs (see Appendix A). Specific BMP practices that are applicable to this project include: Vegetation A Ground Base Skidding and Harvesting, and Vegetation C Mechanical Site Treatments.

3.4 Executive Orders

Executive orders 11988 and 11990 direct federal agencies to avoid impacts to floodplains and wetlands, respectively. Agencies are directed to avoid construction and development in floodplains and wetlands whenever there are feasible alternatives.

3.4.1 Protection of Wetlands

Executive Order 11990 directs all federal agencies to avoid impacts to wetlands. The US Army Corps of Engineers protects wetlands under the Clean Water Act Section 404 regulations.

3.4.2 Floodplain Management

Executive Order No. 11988 requires federal agencies to provide leadership and to take action to:

- minimize adverse impacts associated with occupancy and modification of floodplains and reduce risks of flood loss;
- minimize the impacts of human safety, health, and welfare; and
- restore and preserve the natural and beneficial values served by floodplains.

4. Analysis Methods

The Proposed Action is designed to improve the health of the forest and increase its resiliency to large-scale, high intensity wildfire, insect epidemics and disease. The forest condition that would be created would much more open and would more closely resemble the historic conditions. However, there is some concern that the actions required to move the forest closer to a more resilient forest condition could create water quality problems. This analysis focuses on water yield, peak flows and sediment yield.

4.1 Water Yield

Increases in water yields from forest treatments have generally been regarded as a positive effect of forest management in the semi-arid West. Due to the limited amount of water available generally in ponderosa pine forests, many watershed studies have been conducted to determine how to increase water yield. MacDonald and Stednick (2003) conducted a literature review of water yield studies. That literature review found that water yield increases from timber harvesting are relatively short-lived, lasting on the order of 8-13 years. The magnitude of water yield increases tend to decline following treatments due to revegetation. Sheppard and

Battaglia (2002) confirm the results of MacDonald and Stednick and add that the level of treatment needed would be 20-25 percent of the forest to realize and sustain increased water yields. Additional research on the cumulative effects of fuels reduction efforts has concluded that the consensus is that fuel management activities would likely not increase water yield unless more than 20 percent of the basal area in a watershed is removed (Elliot et al. 2010). For this analysis, potential water yield increases will be evaluated by the amount of total basal area removed by watershed.

4.2 Peak Flow

Forest management activities have been extensively studied with regard to the effects of timber harvesting and road building on changes in peak flows. The consensus in the literature is that peak flow changes from timber harvesting generally occur during drier seasons (Harr 1979) where the amount of evapotranspiration exceeds available soil moisture. During the summer and fall, the trees are generally transpiring soil moisture that is not being recharged by rainfall. When the tree density, and consequently transpiration, is reduced, the soil moisture remains higher and there is a greater potential for runoff from summer or fall storms.

Road drainage systems may alter a stream's hydrograph. These changes occur when subsurface and surface flow is captured at road cuts and in ditches, and redirected into a channel (USDA Forest Service 2001). Roads can also direct water away from a stream (USDA Forest Service 2001). The effects of road drainage can include an increase in the peak discharge, changes in the shape and timing of the hydrograph, increases in the total discharge, and a decrease in water quality (USDA Forest Service 2001). Roads that are in close proximity to streams and road-stream crossings may cause changes to a stream's hydraulic regime, reduction in water quality, and sedimentation (USDA Forest Service 2001).

Increases in runoff and peak flow events following wildfire can be of concern in watersheds that have a higher probability of flooding and debris flows (Cannon and Reneau 2000). Increased runoff from burned areas, combined with erosion, may result in significant sedimentation downstream (Moody and Martin 2001).

Higher peak flows could result in changes in channel dynamic equilibrium. If the channel is moved out of dynamic equilibrium, the integrity of pools and riffles may be compromised and fish habitat could decrease. The most recent research findings have concluded that in snow zones, thinning less than 40 percent of a watershed would result in only a 14 percent increase in the size of peak flows (Elliot et al. 2010). Increases in peak flows by themselves do not constitute an adverse impact. However, when they adversely impact the beneficial uses of a stream they would be considered a violation of the Forest Plan. For this analysis, potential peak flow increases will be evaluated by the percentage of watersheds treated by treatment type.

4.3 Sediment Yield

Watershed cumulative effects from sediment are an important concern in managed watersheds (Megahan and Hornbeck 2000). Sediments that reach the stream system can stay in the channel for years and create instream sediment sources that may have impacts at the site and downstream. Riparian vegetation provides a wide variety of benefits to stream systems, including providing shade to control stream temperature, root strength to maintain stream banks, and input of nutrients that form the base of many aquatic food webs (Bisson et al. 1987). Riparian areas can also serve as filters for increased sediment generated upslope. Stream buffers have been shown to be very effective in moderating cumulative watershed effects (Thomas et al. 1993 and Elliot et al. 2010).

Sediment yield changes following forest management in ponderosa pine has been studied in several locations. Experimental watersheds in Arizona show that sediment yield in managed ponderosa pine forests were low (Rich et al. 1961) and most sediments moved during larger storms and originated from the channels and logging roads (Rich and Gottfried 1976). Other studies have shown basically no changes in total sediment production from the various treatments in ponderosa pine compared to the control (Baker et al. 1999). In a recent study comparing the effects of thinning and a wildfire on sediment production in the Colorado ponderosa pine forests, Libohova (2004) found that thinning treatments in ponderosa pine generated basically no increased sediment yield.

Roads are considered the primary contributors of sediments to streams in managed watersheds (Swanson et al. 1981, Amaranthus et al. 1985, Rice and Lewis 1986, Bilby et al. 1989, Donald et al. 1996, Megan and Kidd 1972, Reid and Dunne 1984, Rothacher 1971, Sullivan and Duncan 1981, and Swift 1988). Roads can also impact the ecological integrity of a watershed in many ways. Roads built on erodible soils and with an improperly planned road drainage network can impair the water quality in nearby streams (USDA Forest Service 2001). Under-sized culverts or bridges can wash out contributing to erosion and sedimentation to the levels that can be detrimental to other aquatic resources (USDA Forest Service 2001).

The Water Erosion Prediction Project (WEPP) model was used to compare the changes in sediment yield from prescribed fire, thinning, use of roads and wildfire to the background conditions. The WEPP is a predictive tool used by the USDA-Natural Resources Conservation Service, USDA-Forest Service, USDI-Bureau of Land Management, and others involved in soil and water conservation and environmental planning and assessment. This improved erosion prediction technology is based on modern hydrologic and erosion science, is process-oriented, and is computer-implemented.

The WEPP erosion model is a continuous simulation computer program which predicts soil loss and sediment deposition from overland flow on hillslopes, soil loss and sediment deposition from concentrated flow in small

channels, and sediment deposition in impoundments. In addition to the erosion components, it also includes a climate component which uses a stochastic generator to provide daily weather information, a hydrology component which is based on a modified Green-Ampt infiltration equation and solutions of the kinematic wave equations, a daily water balance component, a plant growth and residue decomposition component, and an irrigation component. The WEPP model computes spatial and temporal distributions of soil loss and deposition, and provides explicit estimates of when and where in a watershed or on a hillslope that erosion is occurring so that conservation measures can be selected to most effectively control soil loss and sediment yield.

FuME WEPP

Fuel Management WEPP (FuME WEPP) is one in a series of the USDA Forest Service's Internet-based computer programs based on the WEPP model. FuME WEPP is designed to predict runoff and sediment yield from fuels management activities. It compares background conditions to hillslope sedimentation from fuels management activities and wildfire.

Forests generally have very low erosion rates unless they are disturbed. Common disturbances include prescribed and wildfire, and vegetation treatment operations. The impact of these operations, however, generally last only for a short time, perhaps one or two years. After that, the rapid regrowth of vegetation soon covers the surface with plant litter, and potential erosion is quickly reduced. In one study, Robichaud and Brown (1999) reported that erosion rates dropped from almost 40 Mg ha-1 the first year after a fire to 2.3 Mg ha-1 the second, and 1 Mg ha-1 the third year. The regrowth of vegetation and subsequent increase in canopy and ground cover overshadow any differences due to climate variation among the years. For any one of the given years, however, the potential erosion depends on the climate.

The WEPP model can be found at:

http://forest.moscowfsl.wsu.edu/cgi-bin/fswepp/fume/fume.pl

Increases in sediment yield by themselves do not constitute an adverse impact. However, when they adversely impact the beneficial uses of a stream they would be considered a violation of the Forest Plan.

FuME WEPP Modeling Assumptions

The following assumptions were used in the FuME WEPP modeling runs.

1. The forest soil type was assumed to fit into the sandy loam classification. The sandy loam has a Universal Soil Classification description as follows; Glacial outwash areas; decomposed granites and sand stone, and sand deposits. The soils in the area are mainly decomposed granites.
2. The Bailey, CO custom climate was used for this modeling.
3. A buffer of 50 feet was used below the modeled slope.
4. The return period of disturbance for wildfire was 35 years.

5. The return period of disturbance for prescribed fire was 35 years.
6. The return period of disturbance for thinning was 50 years.
7. The road density was assumed to be 3 miles per square mile.
8. The slope distribution for the treatment areas is not known. The slopes in the Project Area were categorized and used in the modeling. For the FuME WEPP modeling exercise it was assumed that treatment areas have the following slope distribution;
    - 34 percent of the area averages 10 percent slope
    - 38 percent of the area averages 20 percent slope
    - 29 percent of the area averages 30 percent slope

4.4 Soils Analysis Methods

The analysis of the effects of the proposed actions on soils focuses on compliance Forest Service Handbook (FSH 2509.25) Watershed Conservation Practices Handbook. Management Measure 13 states "Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15 percent of any activity area." For this analysis, potential soil productivity impacts will be evaluated by the percentage of soil impacts in any activity are compared to the 15 percent standard.

4.5 Watersheds for Analysis

The 6th-Level (12 code HUC) watersheds were evaluated to determine if they should be dropped from this analysis of carried forward. Several watersheds have less than 1 percent of their watershed areas proposed for vegetation treatments (Table 5). Their water quality, peak flows, water yield and sediment yield would not be affected due to the very small extent of proposed activities and the use of BMPs. The following watersheds are not analyzed further;

- Buffalo Creek
- Deer Creek
- Pine Creek-South Platte River
- South Platte Canyon

The remaining 4 watersheds identified for further analysis in Table 5 are carried forward in this analysis.

Table 5. Vegetation Treatment by Watershed

Watershed Name	Watershed Area (acres)	Vegetation Treatment (acres)	Percentage of Watershed	Carried Forward in Analyses?
Bailey	15,563	516	3.3%	Yes
Buffalo Creek	20,827	23	0.1%	No
Craig Creek	35,538	604	1.7%	Yes
Deer Creek	17,252	14	0.1%	No
Last Resort Creek-North Fork South Platte River	30,895	3,069	9.9%	Yes
Pine Creek-South Platte River	16,139	1	<0.1%	No
Rowland Gulch-North Fork South Platte River	18,323	5,347	29.2%	Yes
South Platte Canyon	15,102	0	0.0%	No
Totals	**169,639**	**9,574**	**5.6%**	

5. Existing Conditions

This section describes the existing condition of the watersheds within the Crossons-Longview Project Area. Some of the background information is extracted from the Upper South Platte Watershed Assessment (Front Range Watershed Protection Data Refinement Work Group 2009).

Throughout the Project Area, precipitation is variable and ranges from less than 16 inches at lower elevations to approximately 24 inches per year at the highest elevations. January is typically the driest month of the year. Snow provides the majority of precipitation at the higher elevations, occurring in the winter months. At lower elevations the highest precipitation months are July and August when rain occurs primarily from high intensity summer storms, typically as thunderstorms.

Peakflows vary from snowmelt dominated above 7,500 feet to summer rainfall dominated below 7,500 feet. Runoff from melting snow accumulated during the winter month's accounts for a majority of the volumetric discharge draining the watersheds. Snowmelt runoff results in peak streamflows during the months of May and June, when discharge increases dramatically. Streamflows during the late summer fall and winter are typically much lower and originate mainly from groundwater discharge. Streams and creeks in the area are generally high gradient, linear (little meandering) and often tightly confined.

The North Fork of the South Platte River runs through the project area. It is the largest stream and is somewhat lower gradient, more sinuous and carries high streamflow compared to the other streams. The North Fork of the South Platte River also carries water diverted from the western slope. Water from Dillon Reservoir in the Blue River, which is one of the headwaters of the Colorado River, is diverted through the

Roberts Tunnel into the North Fork of the South Platte River above the project area and provides municipal water supply for Denver and Aurora.

5.1 SOILS

Soils within the Crossons-Longview Project Area are derived mostly from decomposed granite parent material. The parent rock is deeply weathered Pikes Peak Granite composed of large crystals. These large crystals then form a mass of coarse-grained material with little clay to serve as binding material and as exchange medium for soil nutrients. These soil particles are highly erodible and may be relatively unproductive due to a lack of soil nutrients.

Soils in the Crossons-Longview Project Area are generally sandy or gravelly loam textured and shallow in depth. Surface horizons are sandy loam in texture, with some organic accumulations at the surface. Rock and gravel content increases with depth. The surface soils become increasingly coarse with an increase in slope gradient. Soils range from 0 inches in the rock types to 40 inches in some timber types and valley bottoms.

The decomposed, granitic soils within the Crossons-Longview Project Area can be eroded when disturbed due to their lack of cohesion. However, due to their coarse nature, they are not easily compacted except during road or trail construction and use. Studies have found that these decomposed, granitic soils maintain high infiltration rates even when used for skid trails (Libohova 2004).

5.2 WATERSHED ASSESSMENT

The potential of a watershed to deliver sediments following wildfire depends on forest and soil conditions, the physical configuration of the watersheds, and the sequence and magnitude of rain falling on the burned area. High-severity fires can cause changes in watershed conditions that are capable of dramatically altering runoff and erosion processes in watersheds. Water and sediment yields may increase as more of the forest floor is affected by fire.

The Upper South Platte Watershed Assessment (Front Range Watershed Protection Data Refinement Work Group 2009) identified and prioritized sixth-level watersheds based upon their risks of generating flooding, debris flows and increased sediment yields following wildfires that could have impacts on water supplies (Front Range Watershed Protection Data Refinement Work Group 2009). The Crossons-Longview Project Area watersheds were all part of the Upper South Platte Watershed Assessment. Some of the components of that watershed assessment are used here to describe the existing conditions of watersheds in the Crossons-Longview Project Area.

5.2.1 *Ruggedness*

Watershed steepness or ruggedness is an indicator of the relative sensitivity to debris flows following wildfires (Cannon and Reneau 2000). The more rugged the watershed, the higher its sensitivity to generating debris flows following wildfire.

Melton (1957) defines ruggedness, R, as;

$$R = H_b A_b^{-0.5}$$

Where A_b is basin area and H_b is basin height measured from the point of highest elevation along the watershed divide to the outlet.

Table 6 displays the ruggedness ratings for selected Crossons-Longview watersheds. The hazard rankings displayed in Table 6 are taken from the Upper South Platte Watershed Assessment. The hazard ranking categories were used in the prioritization and are numbered one though five, with one being the lowest ranking and five being the highest. The hazard rankings provide a broader context for the ruggedness analysis.

Table 6. Crossons-Longview Watershed Ruggedness Rating

Watershed Name	Ruggedness	Hazard Ranking
Bailey	0.1188	3
Craig Creek	0.1565	4
Last Resort Creek-North Fork South Platte River	0.0940	2
Rowland Gulch-North Fork South Platte River	0.0782	1

5.2.2 *Road Density*

Roads can convert subsurface runoff to surface runoff and then route the surface runoff to stream channels, increasing peakflows (Megan and Kidd 1972, Ice 1985, and Swanson et al. 1987). Therefore, watersheds with higher road densities have a higher sensitivity to increases in peak flows following wildfires. Road density in miles of road per square mile of watershed area was used as an indicator of flooding risk.

Table 7 displays the road density ratings for selected Crossons-Longview watersheds. The hazard rankings displayed in Table 7 are taken from the Upper South Platte Watershed Assessment. The hazard ranking categories were used in the prioritization and are numbered one though five, with one being the lowest ranking and five being the highest. The hazard rankings provide a broader context for the road density analysis.

Table 7. Crossons-Longview Watershed Road Density Evaluation

Watershed Name	Road Density (mi./sq.mi.)	Hazard Ranking
Bailey	1.3	2
Craig Creek	0.2	1
Last Resort Creek-North Fork South Platte River	2.4	3
Rowland Gulch-North Fork South Platte River	2.9	4

5.2.3 Soil Erodibility

High-severity fires can cause changes in watershed components that can dramatically change runoff and erosion processes in watersheds. Water and sediment yields may increase as more of the forest floor is consumed (Wells et al. 1979, Robichaud and Waldrop 1994, Soto et al. 1994, Neary et al. 2005, and Moody et al. 2008) and soil properties are altered by soil heating (Hungerford et al. 1991).

The soil erodibility analysis used a combination of two standard erodibility indicators: the inherent susceptibility of soil to erosion (K factor) and land slope derived from Unites States Geological Survey (USGS) 30-meter digital elevation models. The K factor data from the STATSGO spatial database was combined with a slope grid using NRCS (USDA NRCS 1997) slope-soil relationships to create a classification grid divided into slight, moderate, severe and very severe erosion hazard ratings.

The potential soil erodibility ratings were increased in areas of granitic soils based upon the Upper South Platte test case in the Front Range Watershed Work Group (2009). That procedure increased the ranking by up to one category if there is a large percentage of granitic derived soils. Many of the watersheds in Upper South Platte area have substantial areas of granitic derived soils.

The resulting potential soil erodibility risk rankings are shown on Table 8 for selected Crossons-Longview watersheds. The hazard rankings displayed in Table 8 are taken from the Upper South Platte Watershed Assessment. The hazard ranking categories were used in the prioritization and are numbered one though five, with one being the lowest ranking and five being the highest. The hazard rankings provide a broader context for the soil erodibility analysis.

Table 8. Crossons-Longview Watershed Soil Erodibility

Watershed Name	Soil Erodibility Score	Hazard Ranking
Bailey	88	5
Craig Creek	87	5
Last Resort Creek-North Fork South Platte River	88	5
Rowland Gulch-North Fork South Platte River	88	5

5.2.4 Watershed Condition Framework

The US Forest Service completed an assessment of all 6th Level Watersheds on National Forests in 2011. The assessment documents the overall function of each watershed within the Watershed Condition Framework (USDA Forest Service 2011). The condition of each watershed is rated as Properly Functioning, Functioning at Risk, and Functionally Impaired. The watersheds are also given ratings for 12 condition indicators. The condition rating and indicators for the watersheds in the Crossons-Longview Project Area are displayed on Table 9. The data in Table 9 is discussed below for each watershed carried forward in this analysis. The US Forest Service's goal is to improve conditions in the watersheds that are not properly functioning so that their function will improve.

5.3 BAILEY EXISTING CONDITIONS

Bailey is the largest watershed (46,349 acres) in the Crossons-Longview Project Area (Table 5). The North Fork of the South Platte River runs through the watershed with a number of small tributaries joining the river as it flows from Grant to Bailey along Highway 285. The North Fork of the South Platte River runs between the Platte River Mountains in the Lost Creek Wilderness to the south and Mount Logan in the Mount Evans Wilderness Area to the north. Elevations range from about 7,600 to 12,800 feet. The Crossons-Longview Project Area is in the extreme eastern portion of the watershed below the town of Bailey.

The Bailey watershed was rated as a Category 3 for ruggedness (Table 6) which means that it is moderately steep and is somewhat sensitive to debris flows following wildfires (Cannon and Reneau 2000). Road density of 1.3 miles of road per square mile of watershed was rated as a Category 2 (Table 7). Most of the roads in this watershed are located in vicinity of the Town of Bailey. Soil erodibility was rated as very high at Category 5, compared to the other watersheds (Table 8). This watershed does have a high percentage of granitic soils which increases the potential for erosion. The Bailey watershed was classified as Functioning at Risk in the Watershed Condition Framework (Table 9). It received poor ratings for aquatic biota and aquatic habitat.

5.4 Craig Creek Existing Conditions

The Craig Creek watershed is about 21,625 acres in size (Table 5). Craig Creek runs between the Platte River Mountains to the north and the Kenosa Mountains to the south within the Lost Creek Wilderness Area. Elevations range from about 7,600 to 12,400 feet. The Crossons-Longview Project Area is in the extreme eastern portion of the watershed just before Craig Creek joins the North Fork of the South Platte River.

The Craig Creek watershed was given the highest rating (Category 4) for ruggedness in the Project Area (Table 6) which means that it is very steep and is sensitive to debris flows following wildfires (Cannon and Reneau 2000). Road density of 0.2 miles of road per square mile of watershed is very low and was rated as a Category 1 (Table 7). The few roads in this watershed are located at the bottom of the watershed in vicinity. Soil erodibility was rated as very high at Category 5, compared to the other watersheds (Table 8). This watershed has a high percentage of granitic soils which increases the potential for erosion. The Craig Creek watershed was classified as Properly Functioning in the Watershed Condition Framework (Table 9). It received a poor rating for aquatic biota.

5.5 Last Resort Creek-North Fork South Platte River Existing Conditions

The Last Resort Creek-North Fork South Platte River watershed is about 29,921 acres in size (Table 5). The North Fork of the South Platte River runs through the southern portion of the watershed. EAST AND west Resort Creek and Kennedy Gulch drain into the North Fork of the South Platte River, which joins the South Platte River at the eastern end of this watershed. Elevations range from about 6,100 to over 9,100 feet. The Crossons-Longview Project Area is in the southern portion of the watershed.

The Last Resort Creek-North Fork South Platte River watershed has one of the lower ratings (Category 2) for ruggedness (Table 6). Road density of 2.4 miles of road per square mile of watershed is relatively high and was rated as a Category 3 (Table 7). Soil erodibility was rated as very high at Category 5, compared to the other watersheds (Table 8). This watershed has a high percentage of granitic soils which increases the potential for erosion. The Last Resort Creek-North Fork South Platte River watershed was classified as Functioning at Risk in the Watershed Condition Framework (Table 9). It received poor ratings for aquatic biota, riparian/wetland vegetation, aquatic habitat and rangeland vegetation.

5.6 Rowland Gulch-North Fork South Platte River Existing Conditions

The Rowland Gulch-North Fork South Platte River watershed is about 27,130 acres in size (Table 5). The North Fork of the South Platte River runs through the middle of the watershed. Roland Gulch drains the northern part of the watershed into the North Fork, and Holmes Gulch and Buck Gulch drain the southern portion. Elevations

range from 6,600 feet near the town of Buffalo Creek to over 8,800 feet. The Crossons-Longview Project Area is in the southern third of the watershed.

The Rowland Gulch-North Fork South Platte River watershed was given one of the lowest ratings (Category 1) for ruggedness (Table 6) which means that it is not steep and is not sensitive to debris flows following wildfires (Cannon and Reneau 2000). Road density of 2.9 miles of road per square mile of watershed is the highest in the Project Area and was rated as a Category 4 (Table 7). Soil erodibility was rated as very high at Category 5, compared to the other watersheds (Table 8). This watershed has a high percentage of granitic soils which increases the potential for erosion. The Rowland Gulch-North Fork South Platte River watershed was classified as Impaired Function in the Watershed Condition Framework (Table 9). It received poor ratings for aquatic biota, riparian/wetland vegetation, aquatic habitat and forest cover.

6. EFFECTS

This section describes the effects of Alternative A (No Action), Alternative B (Proposed Action), and Alternative C on the watersheds and soils of the Crossons-Longview Project Area. The analysis concentrates on the potential effects of the alternatives on water yield, peak flows, sediment yield and soil productivity (see 4. Analysis Methods). The cumulative effects assessment includes the watersheds of the Crossons-Longview Project Area (Table 3).

6.1 ALTERNATIVE A (NO ACTION)

6.1.1 Direct and Indirect Effects

Alternative A (No Action) would have no direct short term effect on the watersheds or soils of the Crossons-Longview Project Area. No vegetation treatments would be implemented under this alternative. Indirect effects include an increase in forest density over time that would have an increased risk of catastrophic wildfire compared to the existing conditions.

6.1.2 Cumulative Effects

This section presents the potential cumulative effects of the past, present and future foreseeable actions in the watersheds of the Crossons-Longview Project Area (Table 3). Under Alternative A, there would be no vegetation treatments on National Forest System (NFS) lands in the Crossons-Longview Project Area. While the recent and on-going vegetation treatments on private lands within the Crossons-Longview Project Area would help to reduce stand densities and create a more diverse landscape, NFS lands cover twice the area compared to private lands. Without any treatments on these lands, a large portion of the Crossons-Longview Project Area would be characterized by relatively dense stands of ponderosa pine and mixed conifer.

The cumulative effect of the past, present and reasonably foreseeable future actions on the condition of the forest vegetation in the Crossons-Longview Project Area under Alternative A, would be an area dominated by forest stands that are generally healthy but relatively homogenous in age and structure and increasingly at risk to insects, disease, and wildfire.

Sediment, at some level, is naturally occurring in the environment. The stream systems have adapted to and function at different levels and ranges. The introduction of sediment from human associated activity, if excessive, can adversely impact stream function. Past activities, usually road related, in the Crossons-Longview Project Area have likely contributed a large amount of sediment to the streams. Existing road stream crossings and other contributions from roads in the Crossons-Longview Project Area are expected to remain unchanged.

Several streams in the Project Area have had increased sediment delivered from recent wildfires. Cumulative impacts from sediment produced by the effects of future high intensity wildfires would be expected if a large, intense wildfire burned in the Crossons-Longview Project Area. This alternative would be expected to have the largest number of acres classified at high fire risk of the alternatives. High intensity fires can cause chain reactions of events that can impact watersheds. In general, high severity burn areas experience significant duff reduction and loss in soil nutrients (Harvey et al. 1989) and soil heating (Hungerford et al. 1991). Water and sediment yields may increase as more of the forest floor is consumed (Robichaud and Waldrop 1994; Soto et al. 1994; and Wells et al. 1979). If fire consumes the duff and organic layers of the soil and the mineral soil is exposed, soil infiltration and water storage capacities of the soil are reduced (Robichaud 1996), which can result in increased erosion, runoff and sediment yield. Increased runoff from burned areas, combined with erosion, may result in significant sedimentation downstream (Moody and Martin 2001). Increased water yield and peak flows would also result from a high intensity wildfire.

6.2 Alternative B (Proposed Action)

6.2.1 Direct and Indirect Effects

Vegetation treatments are proposed under Alternative B (Proposed Action) that would treat up to 9,575 acres in a variety of forest and vegetation types. Tree thinning, prescribed fire and mechanical fuels treatments would all be used to reduce wildland fuels, reduce the wildfire hazard, and maintain the diversity and health of the forest vegetation within the Crossons-Longview Project Area.

Water Yield

Water yield would be expected to increase in the short-term from tree removal and consequent reduction of evapotranspiration. This analysis criteria for increases in water yield is estimated basal removal being not more than 20 percent in a watershed (see 4.1 Water Yield). The analysis that was completed to estimate basal area removal by watershed used the following assumptions;

1. Treatments in aspen and gambel oak would not create any changes in water yield because they would quickly resprout.
2. Treatments in dry ponderosa, mesic ponderosa and mixed conifer would result in reductions in basal area of 60, 50 and 40 percent, respectively, for those areas treated. Lodgepole pine was assigned 100 percent because the treatments could include clearcuts.
3. Changes in basal area on a watershed basis were estimated by converting the basal area removal to an acre basis. For example, mesic ponderosa treated in Last Resort Creek-North Fork South Platte River is estimated to be 604 acres. Assuming 50 percent basal area removal, the basal area removal for that watershed would be estimated to be 302 acres, or 50 percent of 604 acres (Table 9).
4. Analysis Areas are the sixth-level watersheds in Table 9.

Table 9. Water Yield - Basal Area Removal Analysis by Watershed[2] - Alternative B (Proposed Action)

Watershed Name	Watershed Area (acres)	Xeric Ponderosa	Mesic Ponderosa	Mixed Conifer	Lodgepole Pine	Totals	Percent of Watershed
Bailey	46,349	156.3	67.2	28.8	45.8	298.1	0.6%
Craig Creek	21,625	37.2	26.7	60.6	278.6	403.1	1.9%
Last Resort Creek-North Fork South Platte River	29,921	1,389.1	301.8	50.0	0.0	1,740.9	5.8%
Rowland Gulch-North Fork South Platte River	27,130	1,162.0	1,435.5	99.2	232.3	2,929.0	10.8%
Totals	**125,025**	**2,744.6**	**1,831.2**	**238.6**	**556.7**	**5,371.1**	**4.3%**

Water yield increases would not be measurable in all watersheds. This conclusion is based on the estimated basal removal of not more than 20 percent in a watershed (Table 9). This analysis shows basal area removal of less than 11 percent in all watersheds (Table 9). Water yield increases would have to adversely impact the beneficial uses of a stream before they would be considered a violation of the Forest Plan. Several recent studies have concluded that water yields have decreased substantially since the late 1800s (Elliot et al. 2010). The direct and indirect effects of Alternative B (Proposed Action) on water yields would be a slight potential to increase water yields in all watersheds listed in Table 9 but those changes would be less than measurable. The beneficial uses of streams in the watersheds that would have treatments would not be adversely impacted from potential increases in water yields.

[2] The numbers in this table represent the number of acres within each watershed that represent 100 percent basal area removal. This analysis assumes that aspen and gambel oak would quickly resprout and not create any changes in water yield. The basal area changes in dry ponderosa, mesic ponderosa and mixed conifer were estimated to be an average of 60, 50 and 40 percent, respectively, for treated stands.

Peak Flows

The direct and indirect effects of Alternative B (Proposed Action) could result in increases in peak flows (see 4.2 Peak Flow). The most recent research findings have concluded that in snow zones, thinning less than 40 percent of a watershed would result in only a 14 percent increase in the size of peak flows (Elliot et al. 2010). Increases in peak flows by themselves do not constitute an adverse impact. However, when they adversely impact the beneficial uses of a stream they would be considered a violation of the Forest Plan. For this analysis, potential peak flow increases will be evaluated by the percentage of watersheds treated by treatment type.

The analysis that was completed to estimate changes in peak flows by watershed used the following assumptions;

1. Treatments in aspen and gambel oak would not create any changes in peak flows because they would quickly resprout.
2. Analysis Areas are the sixth-level watersheds in Table 10.

Table 10. Peak Flow Analysis by Watershed - Alternative B (Proposed Action)[3]

Watershed Name	Watershed Area (acres)	Vegetation Treatment (acres)	Percentage of Watershed
Bailey	46,349	516	1.1%
Craig Creek	21,625	604	2.8%
Last Resort Creek-North Fork South Platte River	29,921	3,069	10.3%
Rowland Gulch-North Fork South Platte River	27,130	5,347	19.7%
Totals	**125,025**	**9,536**	

Peak flow increases would not be measurable in all watersheds on Table 10. This conclusion is based on thinning in less than 40 percent of a watershed would result in only a 14 percent increase in the size of peak flows (Table 10). The Rowland Gulch-North Fork South Platte River watershed is estimated to be just below 20 percent of the watershed treated after full implementation of the Proposed Action. Activities in the Rowland Gulch-North Fork South Platte River watershed should be staged throughout the 10 years of expected implementation of Alternative B (Proposed Action) which would minimize the peak flow increases in that watershed. Elliot and others (2010) also state that "In conclusion, both the available data and our understanding of hydrologic processes indicate that thinning should generally have little or no effect on the size of peak flows."

[3] Please note that the total vegetation treatments acres to do match Alternative B (Proposed Action) because some of the watersheds were dropped from further analysis.

Peak flow increases would have to adversely impact the beneficial uses of a stream before they would be considered a violation of the Forest Plan. The direct and indirect effects of Alternative B (Proposed Action) on peak flows would be a potential slight increase in peak flows in Rowland Gulch-North Fork South Platte River watershed and changes in all other watersheds that are less than measurable. The beneficial uses of streams in the watersheds that would have treatments would not be adversely impacted from potential increases in peak flows.

Sediment Yield

The direct and indirect effects of Alternative B (Proposed Action) could result in increases in sediment yield (see 4.3 Sediment Yield). However, increases in sediment yield by themselves do not constitute an adverse impact. However, when they adversely impact the beneficial uses of a stream they would be considered a violation of the Forest Plan.

Changes in sediment yield were estimated using the FuME WEPP model. The model was run for three slope categories; 10, 20 and 30 percent. The model compares background average annual hillslope sedimentation to that generated from prescribed fire, thinning, wildfires and roads. These modeling runs estimate the changes for hillslopes that would be treated and are only estimates for those portions of the watersheds. The estimates of increased sedimentation were scaled to a watershed basis by the area treated in those watersheds. For example, in the Rowland Gulch-North Fork South Platte River watershed the sedimentation increase is the modeled increase times 0.197, because the treatments cover about 19.7 percent of the watershed.

The results for the FuME WEPP model are presented in Appendix B and summarized by watershed in Table 11. The results show that the effects of vegetation treatments are predicted to be similar to potential sedimentation sources for prescribed fire for all watersheds. The effects of prescribed fire are predicted to be less than two percent for all watersheds (Table 11). The effects of vegetation treatments, which include increased road use, are predicted to be approximately a two percent increase over background, or less (Table 11.) The combined effects of vegetation treatments, road use and prescribed fire added together are predicted to be approximately four percent, or less.

Table 11. FuME WEPP Increased Sedimentation by Watershed - Alternative B (Proposed Action)

Watershed Name	Thinning Effects	Prescribed Fire Effects	Combined Thinning & Prescribed Fire Effects
Bailey	0.1%	0.1%	0.2%
Craig Creek	0.2%	0.2%	0.5%
Last Resort Creek-North Fork South Platte River	0.9%	0.9%	1.7%
Rowland Gulch-North Fork South Platte River	1.7%	1.7%	3.3%

Roads are considered the primary contributors of sediments to streams in managed watersheds (Swanson et al. 1981, Amaranthus et al. 1985, Rice and Lewis 1986, Bilby et al. 1989, Donald et al. 1996, Megan and Kidd 1972, Reid and Dunne 1984, Rothacher 1971, Sullivan and Duncan 1981, and Swift 1988). In a study comparing the effects of thinning and a wildfire on sediment production in the Colorado ponderosa pine forests, Libohova (2004) found that thinning treatments in ponderosa pine generated basically no sediment yield. Roads on the granitic derived soils in the Crossons-Longview Project Area can be major sources of sediment due to the highly erodible nature of these soils. No new system roads would be constructed in Alternative B (Proposed Action). Temporary roads would be used but would be reclaimed after use.

With the full implementation of the BMPs (Appendix A) the amount of increased sediment from harvest activities would not be expected to result in a significant impact on water quality. The direct and indirect effects of Alternative B (Proposed Action) on sediment yield would be a potential slight increase in sediment yield in the short term (less than five years) and a potential decrease in sediment in the long term (greater than five years) in the Crossons-Longview Project Area.

Soil Productivity

The analysis of the effects of the proposed actions on soils focuses on compliance Forest Service Handbook (FSH 2509.25) Watershed Conservation Practices Handbook. For this analysis, potential soil productivity impacts will be evaluated by the percentage of soil impacts in any activity are compared to the 15 percent standard.

Vegetation treatment activities, including felling, skidding, decking, transporting of logs off-site, and slash disposal, can affect soil resources. Potential effects to soil resources include soil compaction and displacement. Soil erosion can occur when rainstorms occur on sites where the ground cover has been removed and the infiltration rate of soils has been reduced due to compaction.

Vegetation treatments and associated soil disturbance in Alternative B (Proposed Action) would be managed to limit the sum of severely burned and detrimentally compacted, eroded, and displaced land to no more than 15 percent of any land unit. No new system roads would be constructed and temporary roads would comply with BMPs.

With the full implementation of the BMPs (Appendix A) and managing disturbances to less than 15 percent of units, the harvest activities would not be expected to result in significant impacts on soil productivity. The direct and indirect effects of Alternative B (Proposed Action) on soil productivity would be a potential slight decrease in soil productivity in the short term (less than five years) and a potential increase in soil productivity in the long term (greater than five years) in the Crossons-Longview Project Area. Long-term increases in soil

productivity could be achieved from the increases in ground cover due to the opening of the forest canopy in treated areas.

Wetlands

Wetlands in the Crossons-Longview Project Area would be protected by implementation of the BMPs (Appendix A). There would be no direct, indirect or cumulative effects on wetlands from Alternative B (Proposed Action).

Floodplains

Floodplains in the Crossons-Longview Project Area would be protected by implementation of the BMPs (Appendix A). There would be no direct, indirect or cumulative effects on floodplains from Alternative B (Proposed Action).

6.2.2 Cumulative Effects

This section presents the potential cumulative effects of the Alternative B (Proposed Action) and past, present and future foreseeable actions in the watersheds of the Crossons-Longview Project Area.

Additional fuel hazard reduction treatments may be implemented as a result of several Community Wildfire Protection Plans (CWPP) that have been developed for communities within the area. These treatments would be primarily within the wildland urban interface and treat areas at the lower elevations. Most likely within the ponderosa pine, gambel oak, and Douglas fir cover types.

There are no currently planned vegetation treatment projects on National Forest Lands in the Project Area. The scale of the treatments on private lands would be substantially less than those in Alternative B (Proposed Action). Therefore, the cumulative effects on water yield, peak flows and sediment yield would be similar to the direct and indirect effects (see Section 6.2.2 Direct and Indirect Effects).

6.3 ALTERNATIVE C

Alternative C would not use temporary roads and would therefore treat 6,325 acres (Table 12), or a reduction of 3,250 acres compared to Alternative B (Proposed Action). Under Alternative C the design features presented in 6.2.1 Soils and Water Quality Design Features would be required for soil and water quality protection.

6.3.1 Direct and Indirect Effects

Vegetation treatments are proposed under Alternative C that would treat up to 6,325 acres in a variety of forest and vegetation types. Tree thinning, prescribed fire and mechanical fuels treatments would all be used to reduce wildland fuels, reduce the wildfire hazard, and maintain the diversity and health of the forest vegetation within the Crossons-Longview Project Area.

Table 12. Crossons-Longview Alternative C Treatment Areas

Vegetation Type	Area (acres)	Percentage
Xeric Ponderosa pine	2,919	46%
Mesic Ponderosa pine	2,500	40%
Mixed Conifer	422	7%
Lodgepole pine	354	6%
Aspen	115	2%
Shrubs	16	<1%
Total	6,325	

Water Yield

Water yield would be expected to increase in the short-term from tree removal and consequent reduction of evapotranspiration. This analysis criteria and assumptions are the same as Alternative B (Proposed Action) that increases in water yield estimated using basal removal should not be more than 20 percent in a watershed (see 4.1 Water Yield).

Water yield increases would not be measurable in all watersheds. This conclusion is based on the estimated basal removal of not more than 20 percent in a watershed (Table 13). This analysis shows basal area removal of less than 7 percent in all watersheds (Table 13). Water yield increases would have to adversely impact the beneficial uses of a stream before they would be considered a violation of the Forest Plan. Several recent studies have concluded that water yields have decreased substantially since the late 1800s (Elliot et al. 2010). The direct and indirect effects of Alternative C on water yields would be a slight potential to increase water yields in all watersheds listed in Table 13 but those changes would be less than measurable. The beneficial uses of streams in the watersheds that would have treatments would not be adversely impacted from potential increases in water yields.

Table 13. Water Yield - Basal Area Removal Analysis by Watershed[4] - Alternative C

Watershed Name	Watershed Area (acres)	Xeric Ponderosa	Mesic Ponderosa	Mixed Conifer	Lodgepole Pine	Totals	Percent of Watershed
Bailey	46,349	82.2	44.6	23.3	17.9	168.0	0.4%
Craig Creek	21,625	36.6	26.6	23.7	148.3	235.2	1.1%
Last Resort Creek-North Fork South Platte River	29,921	1,037.8	267.7	49.0	0.0	1,354.5	4.5%
Rowland Gulch-North Fork South Platte River	27,130	590.8	906.6	70.2	187.0	1,754.6	6.5%
Totals	**125,025**	**1,747.4**	**1,245.5**	**166.2**	**353.2**	**3,512.3**	**2.8%**

Peak Flows

The direct and indirect effects of Alternative C could result in increases in peak flows (see 4.2 Peak Flow). The most recent research findings have concluded that in snow zones, thinning less than 40 percent of a watershed would result in only a 14 percent increase in the size of peak flows (Elliot et al. 2010). Increases in peak flows by themselves do not constitute an adverse impact. However, when they adversely impact the beneficial uses of a stream they would be considered a violation of the Forest Plan. For this analysis, potential peak flow increases will be evaluated by the percentage of watersheds treated by treatment type. The evaluation criteria and assumptions are the same as those for Alternative B (Proposed Action).

Peak flow increases would not be measurable in all watersheds on Table 14. This conclusion is based on thinning in less than 40 percent of a watershed would result in only a 14 percent increase in the size of peak flows (Table 14). The Rowland Gulch-North Fork South Platte River watershed is estimated to be just below 12 percent of the watershed treated after full implementation of Alternative C. Activities in the Rowland Gulch-North Fork South Platte River watershed should be staged throughout the 10 years of expected implementation of Alternative B (Proposed Action) which would minimize the peak flow increases in that watershed. Elliot and others (2010) also state that "In conclusion, both the available data and our understanding of hydrologic processes indicate that thinning should generally have little or no effect on the size of peak flows."

[4] The numbers in this table represent the number of acres within each watershed that represent 100 percent basal area removal. This analysis assumes that aspen and gambel oak would quickly resprout and not create any changes in water yield. The basal area changes in dry ponderosa, mesic ponderosa and mixed conifer were estimated to be an average of 60, 50 and 40 percent, respectively, for treated stands.

Table 14. Peak Flow Analysis by Watershed - Alternative C

Watershed Name	Watershed Area (acres)	Vegetation Treatment (acres)	Percentage of Watershed
Bailey	46,349	305	0.7%
Craig Creek	21,625	374	1.7%
Last Resort Creek-North Fork South Platte River	29,921	2,388	8.0%
Rowland Gulch-North Fork South Platte River	27,130	3,218	11.9%
Totals	**125,025**	**6,285**	

Peak flow increases would have to adversely impact the beneficial uses of a stream before they would be considered a violation of the Forest Plan. The direct and indirect effects of Alternative C on peak flows would be a potential slight increase in peak flows in Rowland Gulch-North Fork South Platte River watershed and changes in all other watersheds that are less than measurable. The beneficial uses of streams in the watersheds that would have treatments would not be adversely impacted from potential increases in peak flows.

Sediment Yield

The direct and indirect effects of Alternative C could result in increases in sediment yield (see 4.3 Sediment Yield). Changes in sediment yield were estimated using the FuME WEPP model. The model was run for three slope categories; 10, 20 and 30 percent. The model compares background average annual hillslope sedimentation to that generated from prescribed fire, thinning, wildfires and roads. These modeling runs estimate the changes for hillslopes that would be treated and are only estimates for those portions of the watersheds. The estimates of increased sedimentation were scaled to a watershed basis by the area treated in those watersheds. For example, in the Rowland Gulch-North Fork South Platte River watershed the sedimentation increase is the modeled increase times 0.197, because the treatments cover about 19.7 percent of the watershed.

The results for the FuME WEPP model are presented in Appendix B and summarized by watershed in Table 15. The results show that the effects of vegetation treatments are predicted to be greater potential sedimentation sources than prescribed fire for all watersheds. The effects of prescribed fire are predicted to be one percent, or less, for all watersheds (Table 15). The effects of vegetation treatments, which include increased road use, are predicted to be approximately a one percent increase over background, or less (Table 15). The combined

effects of vegetation treatments, road use and prescribed fire added together are predicted to be approximately two percent, or less.

Table 15. FuME WEPP Increased Sedimentation by Watershed - Alternative C

Watershed Name	Thinning Effects	Prescribed Fire Effects	Combined Thinning & Prescribed Fire Effects
Bailey	<0.1%	<0.1%	0.1%
Craig Creek	0.1%	0.1%	0.3%
Last Resort Creek-North Fork South Platte River	0.7%	0.7%	1.4%
Rowland Gulch-North Fork South Platte River	1.0%	1.0%	2.0%

Roads are considered the primary contributors of sediments to streams in managed watersheds (Swanson et al. 1981, Amaranthus et al. 1985, Rice and Lewis 1986, Bilby et al. 1989, Donald et al. 1996, Megan and Kidd 1972, Reid and Dunne 1984, Rothacher 1971, Sullivan and Duncan 1981, and Swift 1988). In a study comparing the effects of thinning and a wildfire on sediment production in the Colorado ponderosa pine forests, Libohova (2004) found that thinning treatments in ponderosa pine generated basically no sediment yield. Roads on the granitic derived soils in the Crossons-Longview Project Area can be major sources of sediment due to the highly erodible nature of these soils. No new system roads or temporary roads would be constructed in Alternative C.

With the full implementation of the BMPs (Appendix A) the amount of increased sediment from harvest activities would not be expected to result in a significant impact on water quality. The direct and indirect effects of Alternative C on sediment yield would be a potential slight increase in sediment yield in the short term (less than five years) and a potential decrease in sediment in the long term (greater than five years) in the Crossons-Longview Project Area.

Soil Productivity

The analysis of the effects of the proposed actions on soils focuses on compliance Forest Service Handbook (FSH 2509.25) Watershed Conservation Practices Handbook. For this analysis, potential soil productivity impacts will be evaluated by the percentage of soil impacts in any activity are compared to the 15 percent standard. The effects of Alternative C would similar but less than those described for Alternative B (Proposed Action).

Wetlands

Wetlands in the Crossons-Longview Project Area would be protected by implementation of the BMPs (Appendix A). There would be no direct, indirect or cumulative effects on wetlands from Alternative C.

Floodplains

Floodplains in the Crossons-Longview Project Area would be protected by implementation of the BMPs (Appendix A). There would be no direct, indirect or cumulative effects on floodplains from Alternative C.

6.3.2 Cumulative Effects

This section presents the potential cumulative effects of the Alternative C and past, present and future foreseeable actions in the watersheds of the Crossons-Longview Project Area.

Additional fuel hazard reduction treatments may be implemented as a result of several Community Wildfire Protection Plans (CWPP) that have been developed for communities within the area. These treatments would be primarily within the wildland urban interface and treat areas at the lower elevations. Most likely within the ponderosa pine, gambel oak, and Douglas fir cover types.

There are no currently planned vegetation treatment projects on National Forest Lands in the Project Area. The scale of the treatments on private lands would be substantially less than those in Alternative C. Therefore, the cumulative effects on water yield, peak flows and sediment yield would be similar to the direct and indirect effects (see Section 6.2.2 Direct and Indirect Effects).

6.4 MONITORING

BMP monitoring would occur during and after management activities. BMP implementation monitoring would occur during management activities primarily through contract administration. BMP effectiveness monitoring would occur one to five years after management activities have ceased and areas would be picked randomly from the available sample pool. Monitoring would focus on the roads associated with the units, as past BMP monitoring of logging activities revealed that there is generally few problems with the units and roads are usually where the concerns exist. District personnel would conduct monitoring.

Monitoring for detrimentally impacted soils would also be completed. Units would be picked randomly from a sample pool one to five years after management activities have ceased. One hundred pace transects would be completed in selected units. Soils monitoring is a Forest-wide program so units within the Crossons-Longview Project Area would be monitored only if those units are randomly selected.

6.4 CONSISTENCY WITH FOREST PLAN

Alternative B (Proposed Action) and Alternative C would both be consistent with all Forest Plan Goals, and General direction, standards and guidelines. Alternative A (No Action) would be consistent with all Forest Plan Goals, and General direction, standards and guidelines, except for the Goals pertaining to increasing water yield.

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Appendix A

National Best Practices Management for Water Quality Crosswalk with Contractual Clauses and Provisions related to Mechanical Vegetation Management Activities

National Best Practices Management for Water Quality Crosswalk with Contractual Clauses and Provisions related to Mechanical Vegetation Management Activities

Veg-2 Erosion Prevention and Control

Objective – Avoid, Minimize, or mitigate adverse effects to soil, water quality, and riparian resources by implementing measures to control surface erosion, gully formation, mass slope failure, and resulting sediment movement before, during, and after mechanical vegetation treatments.

***Applicable clauses to meet the objectives from the 10 Year Front Range Long Term Stewardship Contract (FRLTSC)-**
H.5, H.5.1, H.7, H.7.1, H.7.2, H.10.1, H.10.2, H.12, H.13, H.14, H.15, H.16, H.16.1, H.17, H.17.1, H. 23, H.25, H.25.1, H.26, H.27, H.38, H.39, F.4, G.4, G.4.2, G.4.2.2, G.6.3, G.6.4, G.6.5, G.6.6, G.6.7, and K-F.3.1.

***Applicable provisions to meet the objectives from 2400-6/6T Commercial Timber Sale Contracts (TSC)-**
A16, B5.1, B5.3, WO-C5.31, WO-C5.32, RO-C5.34, RO-C5.36, B6.24, WO-C6.24, RO-C6.312, B6.34, B6.341, B6.342, WO-C6.342, B6.35, B6.36, B6.4, RO-C6.411, B6.42, RO-C6.42, B6.422, B6.5, RO-C6.5, B6.6, RO-C6.6, RO-C6.602, B6.61, B6.62, WO-C6.62, B6.63, B6.64, B6.65, B6.66, and B6.67.

Practices – All of the practices cited under the Veg-2 Erosion Prevention and Control can be mitigated using some or all of the clauses and provisions listed above with the exception of the following;

"Develop an erosion control and sediment plan that covers all disturbed areas including skid trails and roads, landings, cable corridors, temporary road fills, water source sites, barrow sites, or other areas disturbed during mechanical vegetation treatments."

This plan should be developed during the VEG-1 Management Planning Stage. The approved plan can then be implemented using many of the above clauses and provisions for site specific mitigations if needed.

Veg-3 Aquatic Management Zones

Objective – Avoid, Minimize, or mitigate adverse effects to soil, water quality, and riparian resources when conducting mechanical vegetation treatment activities in the AMZ.

***Applicable clauses to meet the objectives from the 10 Year Front Range Long Term Stewardship Contract (FRLTSC)-**
H.5, H.5.1, H.7, H.7.1, H.7.2, H.10.2, H.10.3, H.12, H.13, H.14, H.16, H.16.1, H.17, H.17.1, H.23, H. 25, H.25.1, F.4, G.4, G.4.2.2, G.6.3, G.6.5, G6.6 and G.6.7.

***Applicable provisions to meet the objectives from 2400-6/6T Commercial Timber Sale Contracts (TSC)-**

A16, RO-C2.301, B5.1, B6.24, WO-C6.24, RO-C6.312, B6.34, B6.341, B6.342, WO-C6.601, WO-C6.342, B6.35, B6.4, RO-C6.411, B6.42, RO-C6.42, B6.422, B6.5, RO-C6.5, B6.6, RO-C6.6, RO-C6.602, B6.62, WO-C6.62, B6.63, B6.65, B6.66, and B6.67.

Practices - All of the practices cited under the Veg-3 Aquatic Management Zones can be mitigated using some or all of the clauses and provisions listed above with the exception of the following;

> "Design silvicultural or other vegetation management prescriptions to maintain or improve the riparian ecosystem and adjacent waterbody."

This practice should be addressed during the VEG-1 Management Planning Stage when the prescriptions would be identified. The design can then be implemented using the applicable clauses and provisions listed above.

Veg-4 Ground Based Skidding and Yarding Operations

Objective - Avoid, Minimize, or mitigate adverse effects to soil, water quality, and riparian resources during ground based skidding and yarding operations by minimizing site disturbance and controlling the introduction of sediment, nutrients, and chemical pollutants to waterbodies.

***Applicable clauses to meet the objectives from the 10 Year Front Range Long Term Stewardship Contract (FRLTSC)-**
H.5, H.5.1, H.7, H.7.1, H.7.2, H.10.2, H.12, H.14, H.16, H.16.1, H.17, H.17.1, F.4, G.4, G.4.2, G. 4.2.2, G.6.5, and G.6.6.

***Applicable provisions to meet the objectives from 2400-6/6T Commercial Timber Sale Contracts (TSC)-**
B6.24, WO-C6.24, B6.342, WO-C6.601, WO-C6.342, B6.4, RO-C6.411, B6.42, RO-C6.42, B6.422, B6.5, RO-C6.5, B6.6, RO-C6.6, RO-C6.602, B6.62, WO-C6.62, B6.63, B6.65, B6.66, and B6.67.

Practices – All practices cited under Veg-4 Ground Based Skidding and Yarding Operations can be mitigated using the clauses and provisions listed above.

Veg-6 Landings

Objective - Avoid, Minimize, or mitigate adverse effects to soil, water quality, and riparian resources from the construction and use of log landings.

***Applicable clauses to meet the objectives from the 10 Year Front Range Long Term Stewardship Contract (FRLTSC)-**
H.7, H.7.1, H.7.2, H.12, H.13, H.14, H.16, H.17, G.4, G.4.2.2, and G.6.6.

***Applicable provisions to meet the objectives from 2400-6/6T Commercial Timber Sale Contracts (TSC)-**
B6.24, WO-C6.24, B6.341, B6.342, B6.35, B6.4, RO-C6.411, B6.422, B6.5, B6.6, RO-C6.6, RO-C6.601, RO-C6.602, B6.62, WO-C6.62, B6.64, B6.66, and B6.67.

Practices – All practices cited under Veg-6 Landings can be mitigated using the clauses and provisions listed above.

Veg – 7 Winter Logging

Objective - Avoid, Minimize, or mitigate adverse effects to soil, water quality, and riparian resources from winter logging.

***Applicable clauses to meet the objectives from the 10 Year Front Range Long Term Stewardship Contract (FRLTSC)-**
H.5, H.5.1, H.7, H.7.1, H.7.2, H.10.1, H.10.2, H.12, H.13, H.14, H.15, H.16, H.16.1, H.17, H.17.1, H. 23, H.25, H.25.1, H.26, H.27, H.38, H.39, F.4, G.4, G.4.2, G.4.2.2, G.6.3, G.6.4, G.6.5, G.6.6, G.6.7, and K-F.3.1.

***Applicable provisions to meet the objectives from 2400-6/6T Commercial Timber Sale Contracts (TSC)-**
A16, B5.1, B5.3, WO-C5.31, WO-C5.32, RO-C5.34, RO-C5.36, B6.24, WO-C6.24, RO-C6.312, B6.34, B6.341, B6.342, WO-C6.342, B6.35, B6.36, B6.4, RO-C6.411, B6.42, RO-C6.42, B6.422, B6.5, RO-C6.5, B6.6, RO-C6.6, RO-C6.601, RO-C6.602, B6.61, B6.62, WO-C6.62, B6.63, B6.64, B6.65, B6.66, and B6.67.

Practices – All practices cited under Veg-6 Landings can be mitigated using the clauses and provisions listed above.

Veg – 8 Mechanical Site Treatment

Objective - Avoid, Minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling the introduction of sediment, nutrients, chemical, or other pollutants to waterbodies during mechanical site treatment.

***Applicable clauses to meet the objectives from the 10 Year Front Range Long Term Stewardship Contract (FRLTSC)-**
H.5, H.5.1, H.7, H.7.1, H.7.2, H.10.1, H.10.2, H.12, H.13, H.14, H.15, H.16, H.16.1, H.17, H.17.1, H. 23, H.25, H.25.1, H.26, H.27, H.38, H.39, F.4, G.4, G.4.2, G.4.2.2, G.6.3, G.6.4, G.6.5, G.6.6, G.6.7, and K-F.3.1.

***Applicable provisions to meet the objectives from 2400-6/6T Commercial Timber Sale Contracts (TSC)-**
A16, B5.1, B5.3, WO-C5.31, WO-C5.32, RO-C5.34, RO-C5.36, B6.24, WO-C6.24, RO-C6.312, B6.34, B6.341, B6.342, WO-C6.342, B6.35, B6.36, B6.4, RO-C6.411, B6.42, RO-C6.42, B6.422, B6.5, RO-C6.5, B6.6, RO-C6.6, RO-C6.601, RO-C6.602, B6.61, B6.62, WO-C6.62, B6.63, B6.64, B6.65, B6.66, and B6.67.

Practices - All of the practices cited under the Veg-8 Mechanical Site Treatment can be mitigated using some or all of the clauses and provisions listed above with the exception of the following;

> "Evaluate multiple site factors, including soil conditions, slope, topography, and weather, to prescribe the most suitable mechanical treatment and equipment to avoid or minimize unacceptable impacts to soil while achieving treatment objectives."

This practice should be addressed during the VEG-1 Management Planning Stage when the prescriptions and other resource issues would be identified. The design can then be implemented using the applicable clauses and provisions listed above.

Please reference the applicable contracts for a full description of clauses and provisions. Many of the clauses and provisions allow the FS to write in special mitigation measures to be carried out during project implementation.

Clauses cited from the FRLTSC

H.5 Protection Measures needed for Plants, Animals, Cultural Resources, and Cave Resources

H.5.1 Site Specific Special protection Measures – Fill in

H.7 Erosion Prevention and Control

H.7.1 Erosion Prevention and Control – Fill in

H.10.1 Felling and Bucking (Special Objectives) – Fill in

H.10.2 Skidding and Yarding (Special Objectives). (11/06) – Fill in

H.10.3 Unit Boundaries – Fill in

H.12 Sanitation and Servicing

H.13 Prevention of Oil Spills

H.14 Washing Equipment

H.15 Meadow Protection

H.16 Wetland Protection

H.16.1 Site Specific Wetlands Protection Measures (09/04) – Fill in

H.17 Streamcourse Protection

H.17.1 Streamside Management Zones (11/06) – Fill in

H.23 Authorization

H.25 Temporary Roads

H.25.1 Obliteration of Temporary Roads, Skid Trails, and Landings (11/06) – Fill in

H.26 Use of Roads by the Contractor

H.26.1 Snow Removal

H.27 Road Maintenance

H.38 Camping Provisions for Labor Intense Contracts

Clauses cited from the FRLTSC cont.

H.39 Normal Operating Season – Fill in

F.4 Schedules and Reports – Fill in
Cutting Schedule (04/04)
Sale Operating Restrictions (04/04)

FRLTSC Timber Removal Specifications

G.4 Conduct of Logging

G.4.1 Felling and Bucking

G.4.2 Skidding and Yarding

G.4.2.2 Landings and Skid Trails

G.6.3 Temporary Roads

G.6.4 Landings

G.6.5 Skid Trails and Fire Lines

G.6.6 Current Operating Areas

G.6.7 Erosion Control Structure Maintenance

K-F.3.1 Road Maintenance Requirements – Fill in

Provisions Cited From the TSC

A16 Normal Operating Season

B5.1 Authorization

B5.3 Road Maintenance, WO-5.31 Road Maintenance Requirements – Fill in, RO-C5.34 Obliteration of Temporary Roads – Fill in, RO-C5.36 Snow Removal –Fill in

B6.24 Protection Measures Needed for Plants, Animals, and Cultural Resources, WO-C6.24 Site Specific Protection Measures Needed for Plants, Animals, and Cave Resources – Fill in

RO-C6.312 Sale Operation Restrictions – Fill in

B6.34 Sanitation and Servicing, B6.341 Prevention of Oil Spills, B6.342 Hazard Substances, WO-C6.342 Hazardous Substances

B6.35 Equipment Cleaning

B6.36 Acceptance

B6.4 Conduct of Logging, R0-C6.411 Felling and Bucking (Special Objectives) – Fill in

B6.42 Skidding and Yarding, RO-C6.42 Skidding and Yarding (Special Objectives) – Fill in

B6.422 Landings and Skid Trails

Provisions Cited From the TSC cont.

B6.5 Streamcourse Protection, RO-C6.5 Streamside Management Zones – Fill in

B6.6 Erosion Prevention and Control, RO-C6.6 Erosion Prevention and Control – Fill in, RO-C6.601 Erosion Control Seeding – Fill in, RO-C6.602 Protection of Disturbed Areas from Establishment of Noxious Weeds – Fill in

B6.61 Meadow Protection

B6.62 Wetlands Protection, WO-C6.62 Site Specific Wetlands Protection Measures – Fill in

B6.63 Temporary Roads

B6.64 Landings

B6.65 Skid Trails and Fire Lines

B6.66 Current Operating Areas

B6.67 Erosion Control Structure Maintenance

Appendix B

FuME WEPP Modeling Results

Table B-1. FuME WEPP Modeling Results for 10 Percent Slopes

Source of Sediment	Return Period of Disturbance (years)	Sediment Delivery in Year of Disturbance (tons/sq. mi.)	Average Annual Hillslope Sedimentation (tons/ sq. mi./year)	Increase/Decrease Compared to Background (%)
Undisturbed Forest	1	0.0	0.0	
Wildfire	35	96.0	2.7	
Prescribed Fire	35	6.4	0.2	
Thinning	50	0.0	0.0	
Low Access Road		Low	0.0	
		High	0.7	
High Access Road		Low	0.0	
		High	0.8	
Background Sedimentation (tons/sq. mi./year)		Low	2.7	
		High	3.4	
Thinning Effects (tons/sq. mi./year)		Low	2.7	0%
		High	3.5	3%
Prescribed Fire Effects (tons/sq. mi./year)		Low	2.9	7%
		High	3.6	5%
Combined Thinning & Prescribed Fire Effects (tons/sq. mi./year)		Low	2.9	7%
		High	3.7	8%
Combined Thinning and Prescribed Fire Effects with Wildfire Intensity Reduction (tons/sq. mi./year)		Low	1.6	-42%
		High	4.0	16%

Table B-2. FuME WEPP Modeling Results for 20 Percent Slopes

Source of Sediment	Return Period of Disturbance (years)	Sediment Delivery in Year of Disturbance (tons/sq. mi.)	Average Annual Hillslope Sedimentation (tons/ sq. mi./year)	Increase/Decrease Compared to Background (%)
Undisturbed Forest	1	0.0	0.0	
Wildfire	35	262.4	7.5	
Prescribed Fire	35	25.6	0.7	
Thinning	50	0.0	0.0	
Low Access Road		Low	0.0	
		High	0.8	
High Access Road		Low	0.0	
		High	1.6	
Background Sedimentation (tons/sq. mi./year)		Low	7.5	
		High	8.3	
Thinning Effects (tons/sq. mi./year)		Low	7.5	0%
		High	9.1	10%
Prescribed Fire Effects (tons/sq. mi./year)		Low	8.2	10%
		High	9.0	9%
Combined Thinning & Prescribed Fire Effects (tons/sq. mi./year)		Low	8.2	10%
		High	9.8	18%
Combined Thinning and Prescribed Fire Effects with Wildfire Intensity Reduction (tons/sq. mi./year)		Low	8.2	9%
		High	12.2	46%

Table B-3. FuME WEPP Modeling Results for 30 Percent Slopes

Source of Sediment	Return Period of Disturbance (years)	Sediment Delivery in Year of Disturbance (tons/sq. mi.)	Average Annual Hillslope Sedimentation (tons/ sq. mi./year)	Increase/Decrease Compared to Background (%)
Undisturbed Forest	1	0.0	0.0	
Wildfire	35	422.5	12.1	
Prescribed Fire	35	51.2	1.5	
Thinning	50	0.0	0.0	
Low Access Road		Low	0.0	
		High	0.9	
High Access Road		Low	0.0	
		High	2.6	
Background Sedimentation (tons/sq. mi./year)		Low	12.1	
		High	13.0	
Thinning Effects (tons/sq. mi./year)		Low	12.1	0%
		High	14.7	13%
Prescribed Fire Effects (tons/sq. mi./year)		Low	13.5	12%
		High	14.4	11%
Combined Thinning & Prescribed Fire Effects (tons/sq. mi./year)		Low	13.5	12%
		High	16.1	24%
Combined Thinning and Prescribed Fire Effects with Wildfire Intensity Reduction (tons/sq. mi./year)		Low	10.1	-16%
		High	16.8	30%